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Abstract

- The Family of Advanced Cost Estimating Tools (FACET) has been used around the world as a macro parametric cost model during the early stages of a project life cycle. It has been used to explore concept options, set early budgets and conduct independent cost estimates (ICE) with minimal information. With more than fifty system level cost models, covering space, land, sea and air domains, FACET has provided early and reliable conceptual costs since its inception in 1986.

- FACET has a unique capability as it addresses the shortcoming of other parametric cost models through an interpretation of the performance requirements into a design. Taking both the performance and the design characteristics of a concept the model utilises Bayesian combination to seamlessly transition from performance based estimating to design based estimating. At the same time it will make initial observation on the risk of the concept design at an early project life cycle phase thus safeguarding against entry-ism or inadequate budgets.

- Furthermore, FACET has the unique capability to combine three point estimate inputs and algorithm uncertainty. Considering both distributions and combining them is the only means of producing a true cost estimate that reflects the potential outcome of the parametric modelling.

- This year sees an exciting new development as PRICE systems and QinetiQ have joined forces to deliver both sets of algorithms in the well-established TruePlanning cost modelling framework. It is now possible to access the best cost tool for the project life cycle in one easy to use interface giving you outstanding cost and schedule forecasting capability through a hybrid product breakdown structure of parametric cost models; either FACET, PRICE or both.

- This paper will explore the development of this ultimate cost forecasting solution, its applications and benefits.

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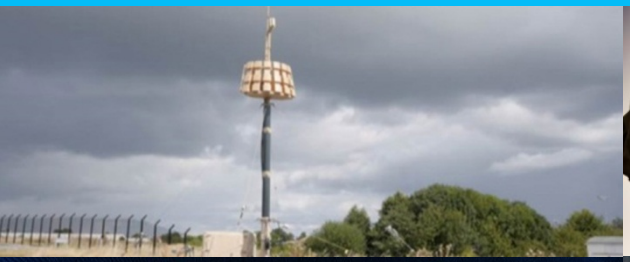
Marco-parametrics; its unique capability and application

International Cost Estimating and Analysis Association (ICEAA) Portland, Oregon, USA








Dale Shermon

Arlene Minkiewicz

6 to 9 June 2017

QINETIQ/EMEA/PAS/PUB17-00047

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Agenda

1. QinetiQ and PRICE Systems
2. True FACET IRAD
3. FACET White Paper
4. True FACET
5. Applications of True FACET
6. Summary

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QinetiQ and PRICE Systems

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QinetiQ Businesses

Air and Space

Maritime, land and weapons

North America

Cyber, Information & training

OptaSense®

International

PRICE

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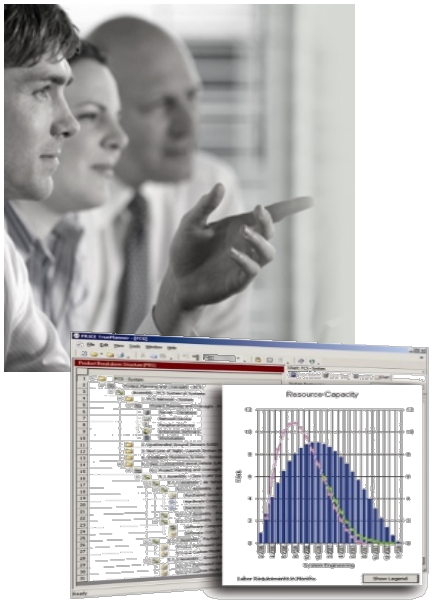
PRICE Systems



- We improve our customers overall *cost management* to help them increase revenue and save money. By empowering our clients with *proven cost models and predictive cost analytics*, they become better estimators - improving bid success ratios, and achieving tremendous savings in analyzing alternatives. They become confident in their costs, schedules, and risk estimates

- Founded as an RCA business in 1975, taken private in 1998
- Headquarters: Mt. Laurel, NJ with additional offices in *DC, OH, VA, UK, France, Germany*
- Partner companies: China, S.Korea, Japan, Australia, Italy, Germany, and elsewhere
- Products: TruePlanning® software, PRICE Models, benchmark databases, integrated processes, and implementation services
- Education: PRICE University, instructor-led training on best estimating practices and product implementation
  350+ customers & 12,000+ project professionals trained worldwide

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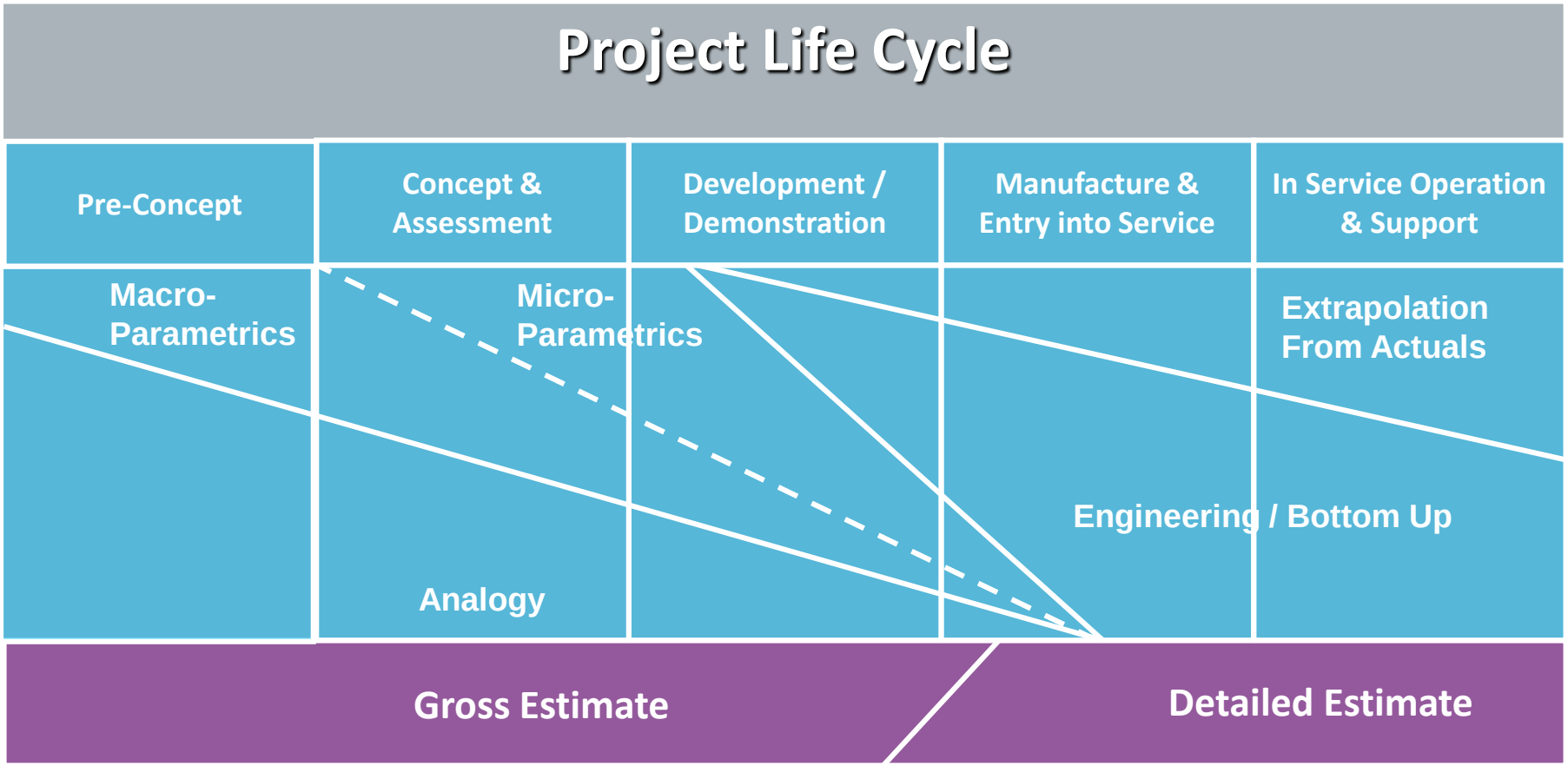
Cost Modelling Capability



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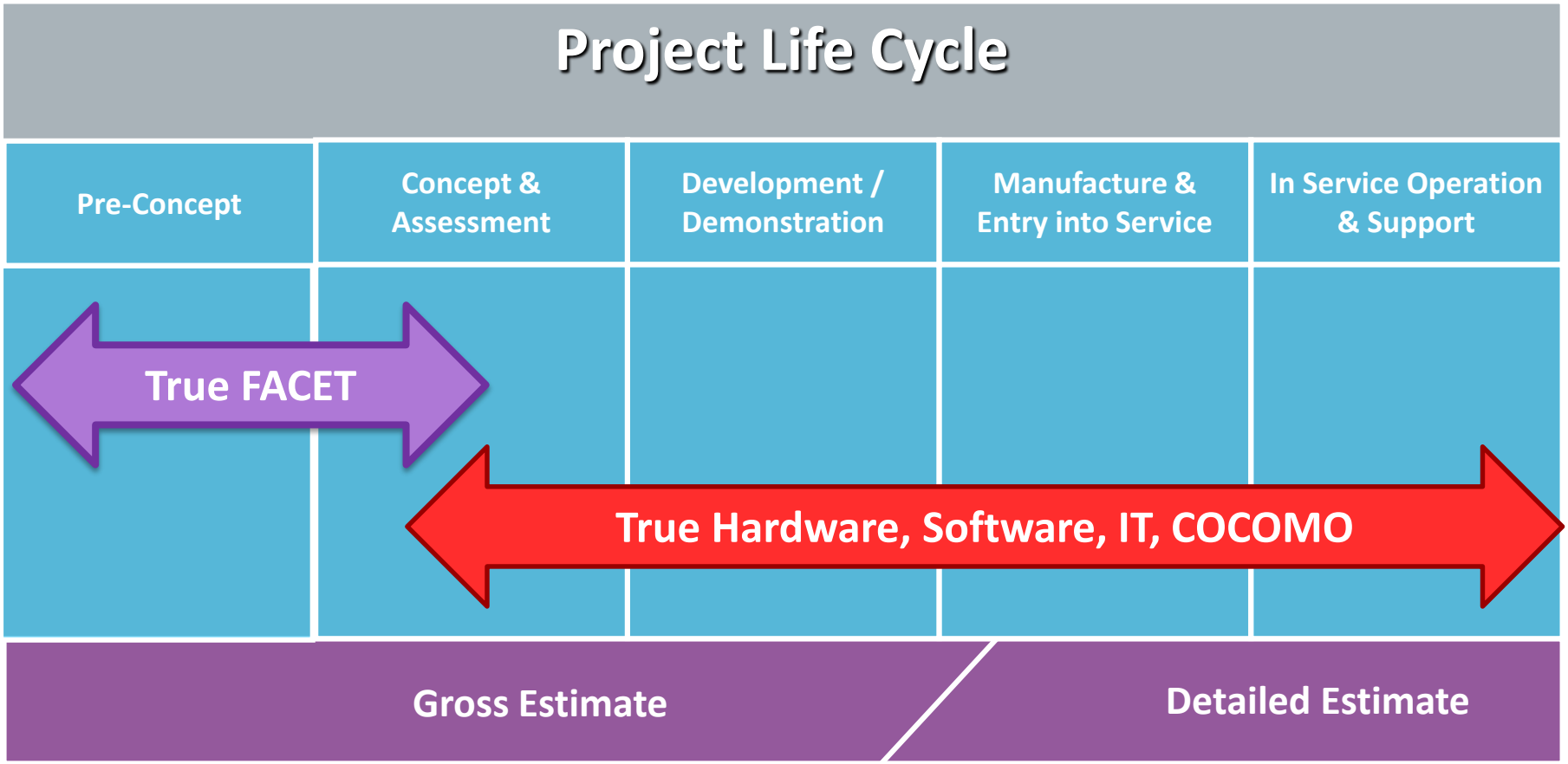
Cost Modelling Capability: complementary



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IRAD True FACET

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FACET Cost Object development programme

Work Structure

Development

Maintenance

Increments

Prototype

Initial Operating Capability

Full Operating Capability

Support

Progress meetings

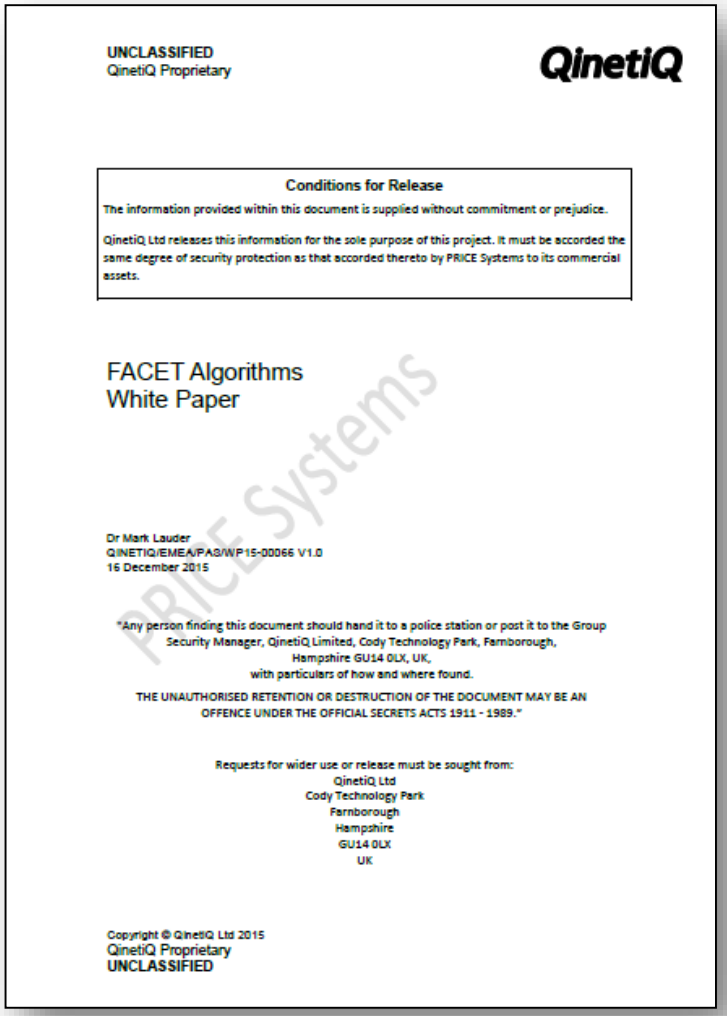
Milestones

- Start up Meeting
- Prototype Delivery
- Preliminary Design Review
- IOC Delivery
- Critical Design Review
- FOC Delivery
- Delivery to Customer
- Annual FACET Cost Object Upkeep and Updates

Requirements overview	• Stakeholder start up meeting • Receipt of FACET White Paper • Implementation of the FACET Algorithms in TruePlanning • PRICE Quality Assurance of the FACET Cost Object. • Support to QinetiQ testing	• Implementation of all the GEM models to the prototype standard • Correction of all error and bugs resulting from prototype testing • Support to QinetiQ testing	• Correction of all error and bugs resulting from IOC testing • Implementation of the PRICE Licensing system • Implementation of the full help system • Training of the help desk and consultants	• Annual update of the FACET Cost Objects aligned to the updated FACET White Paper. • Annual upkeep of the TruePlanning framework to provide continued access to the FACET Cost Objects • Upkeep of Help systems
Deliverables	• Start up meeting pack • TruePlanning framework • One FACET Cost Object	• All FACET Cost Objects in the Catalogue implemented in the TruePlanning framework delivered on a development CD	• All FACET Cost Objects in the Catalogue implemented in the TruePlanning framework ready for delivery on a production CD. • Full help systems	• Annual release of the FACET Catalogue
Value	• Initial delivery of the concept providing reassurance that TruePlanning can accommodate the FACET algorithms	• Initial Operating Capability will demonstrate the TruePlanning framework with all GEM models functioning.	• Delivery of the production quality product ready for despatch to customers.	• Continued delivery of cost research from QinetiQ

FACET White Paper

- Partnership agreed with PRICE Systems for the development of the FACET algorithms in TruePlanning environment.
- Licensing agreement signed for the marketing, business development, support and training of the new capability
- Currently final version is being tested



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FACET Algorithms
White Paper

PRICE Systems

Dr Mark Lauder
QINETIQ/EMEA/PAS/WP15-00066 V1.0
16 December 2015

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FACET White Paper

Dale Shermon | Arlene Minkiewicz

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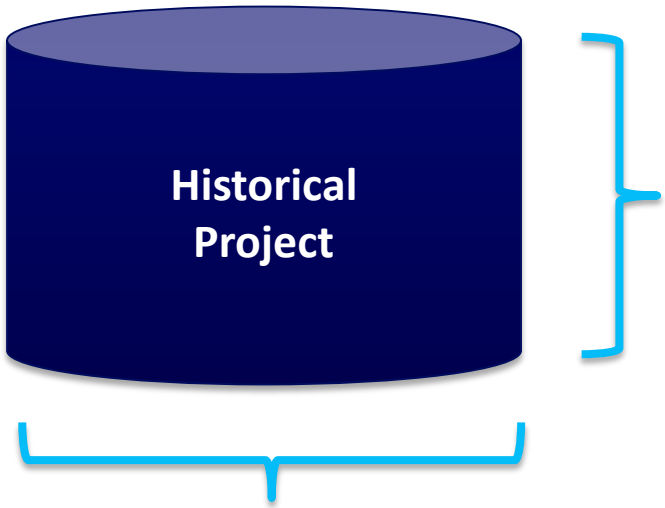
One database: two cost research approaches



Micro-parametrics:

- Technology focus
- Single universal model
- Numerous independent parameters to describe the project

Macro-parametrics:

- Platform / System focus
- Numerous platform models
- Few platform specific independent parameters to describe the platform

True FACET

- The model calculates the life cycle cost (LCC_n) for the system (n) as follows:
- $LCC_n = D_n + PI_n + P_n + C_n + M_n$
- Where
  - D_n = the Development cost
  - PI_n = the Production investment cost
  - P_n = the Production cost
  - C_n = the Crew cost and
  - M_n = the Maintenance cost
- There are more than 50 systems in the True FACET model

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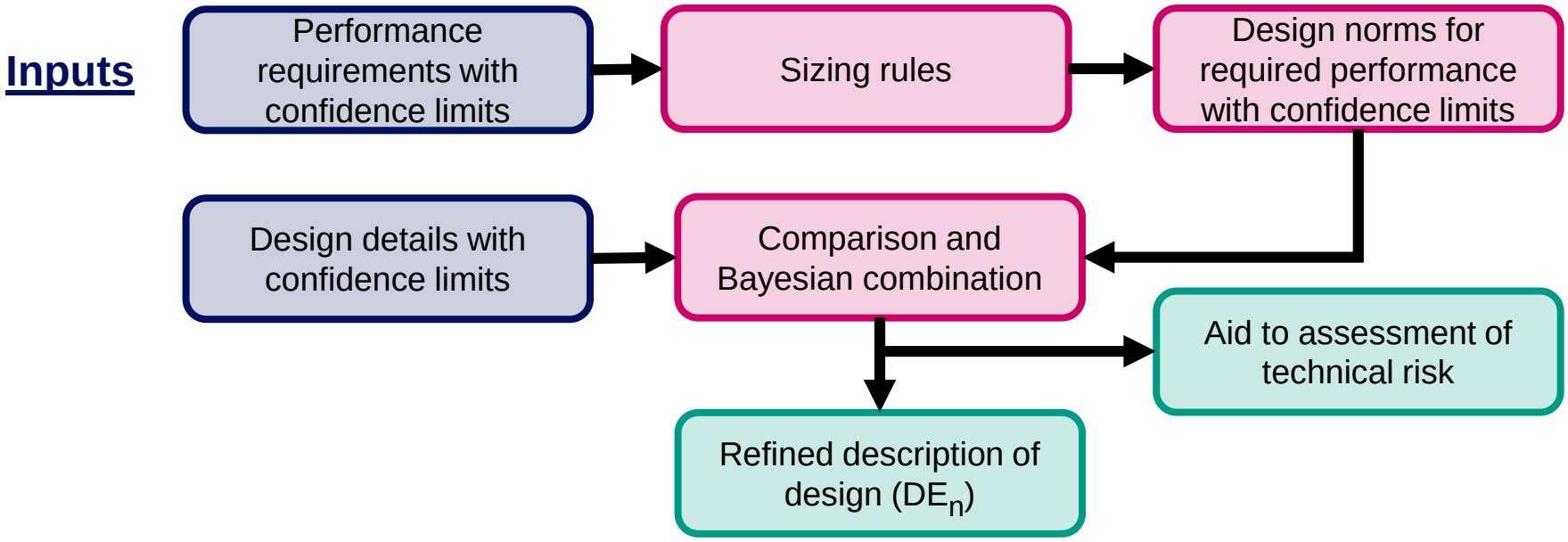
Implementation of a combined performance / design based approach to cost estimating



- It is typical in parametric cost models for the cost drivers to be size (for example weight or SLOC), complexity (for example Technology or functional complexity) and productivity relative to average industry (for example tooling or processes).
- The FACET model cost drivers are Design (DE$_n$), Performance (PE$_n$) and Technology year (T$_n$).

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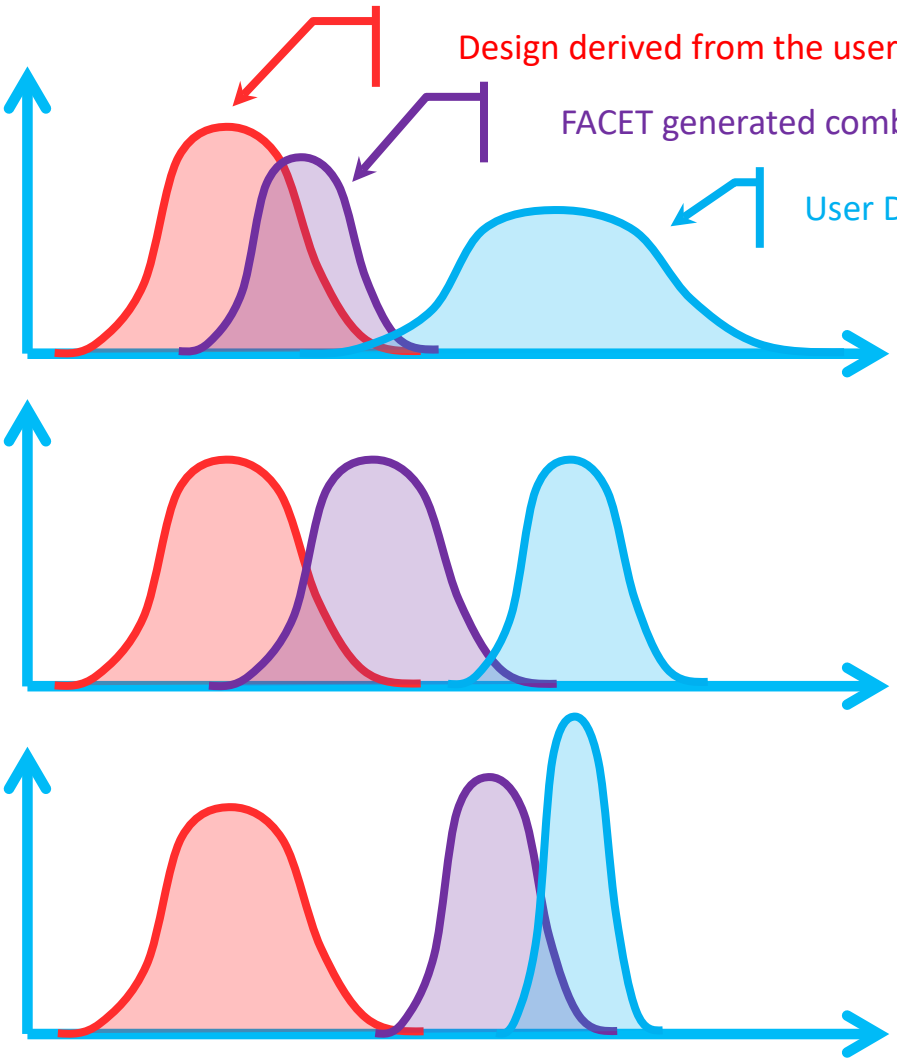
Using Bayesian to merge the user inputs



Performance based cost estimates

Performance / Design based cost estimates

Design based cost estimates

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True FACET

- The model calculates the research, development, test and evaluation (RDT&E) cost (D_n) for the system (*n)* as follows:

- $D_n = \int (DE_n, PE_n, T_n, Nat, Nvar)$

- Where
  - DE_n = the Design parameters
  - PE_n = the Performance parameter
  - T_n = the Technology Year
  - Nat = the number of participating nations in the project
  - Nvar = the number of variants to be developed concurrently with the basic design

- Combined in a mathematical form with a number of constants and coefficient parameters which are derived from statistical analyses of past projects.

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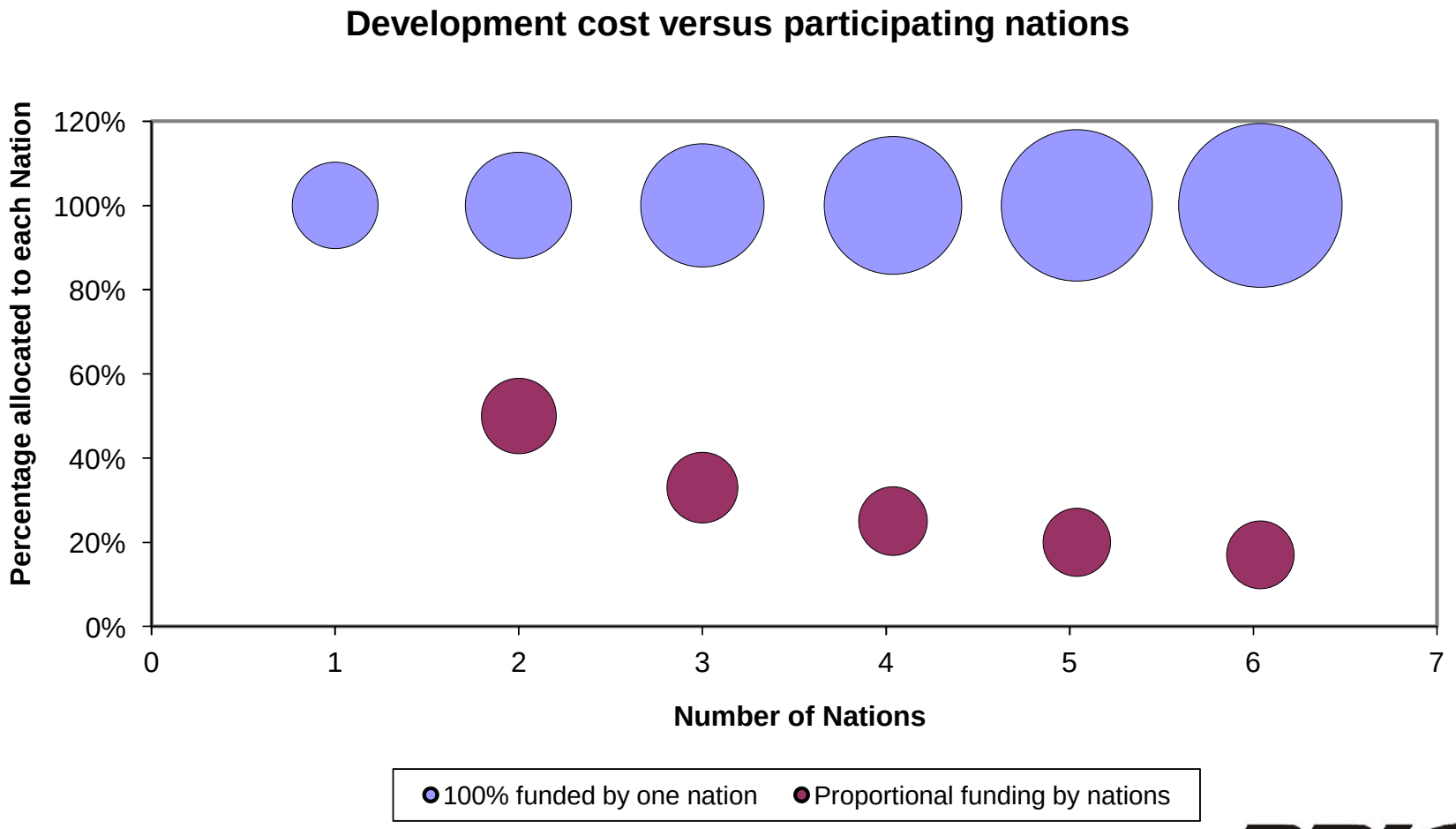
True FACET



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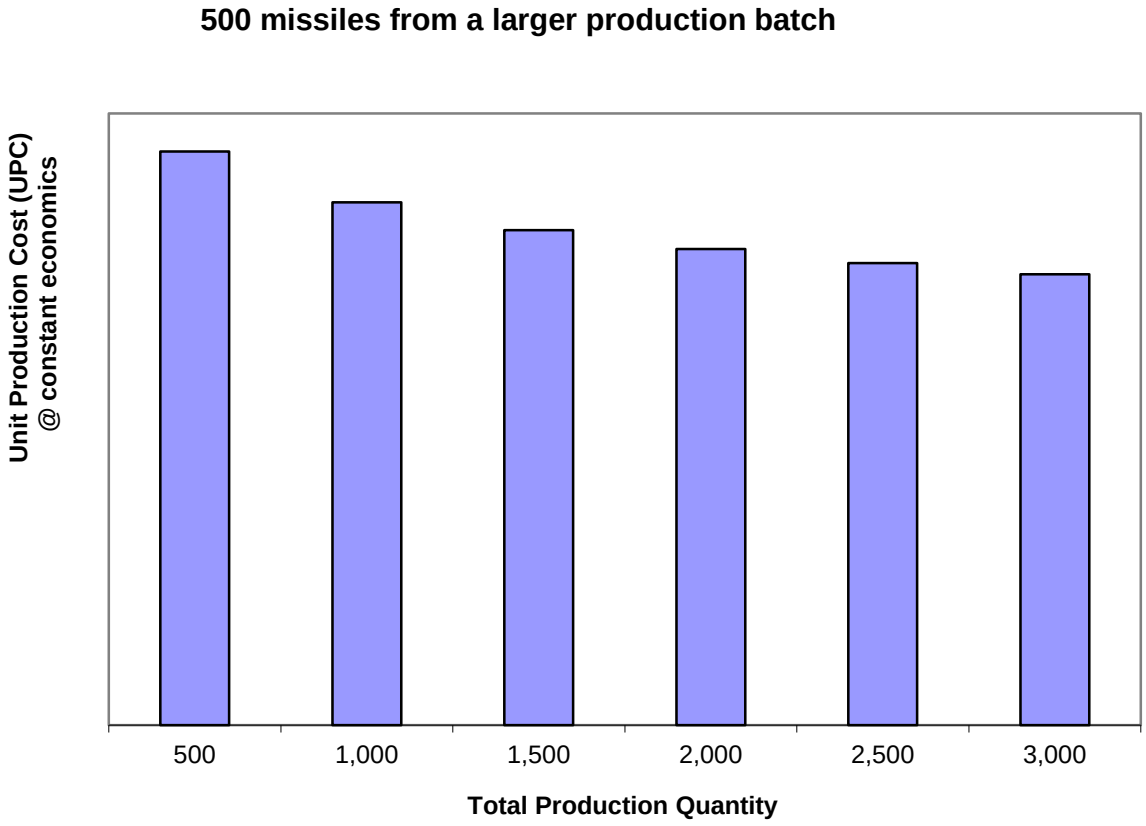
True FACET

- The model calculates the Production cost (P_n) for the system (*n)* as follows:
- $P_n = \int (DE_n, PE_n, T_n, Q_{ref}, R_{ref})$
- Where
  - DE_n = the Design parameters (2 maximum)
  - PE_n = the Performance parameters (2 maximum)
  - T_n = the Technology Year
  - Q_{ref} = the reference quantity in the project
  - R_{ref} = the reference production rate in the project
- Combined in a mathematical form with a number of constants and coefficient parameters which are derived from statistical analyses of past projects.

True FACET

The influence of acquiring a batch of systems from progressively larger production runs.



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True FACET

- The model calculates the Maintenance cost (M_n) for the system (*n)* as follows:
- $M_n = \int (DE_n, PE_n, T_n, Act \quad)$
- Where
  - DE_n = the Design parameters (2 maximum)
  - PE_n = the Performance parameters (2 maximum)
  - T_n = the Technology Year
  - Act = the activity or operating tempo of the system
- Combined in a mathematical form with a number of constants and coefficient parameters which are derived from statistical analyses of past projects.

True FACET

The operating tempo of the system has an influence over the maintenance burden. If the system is not used, it doesn't fail.

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True FACET

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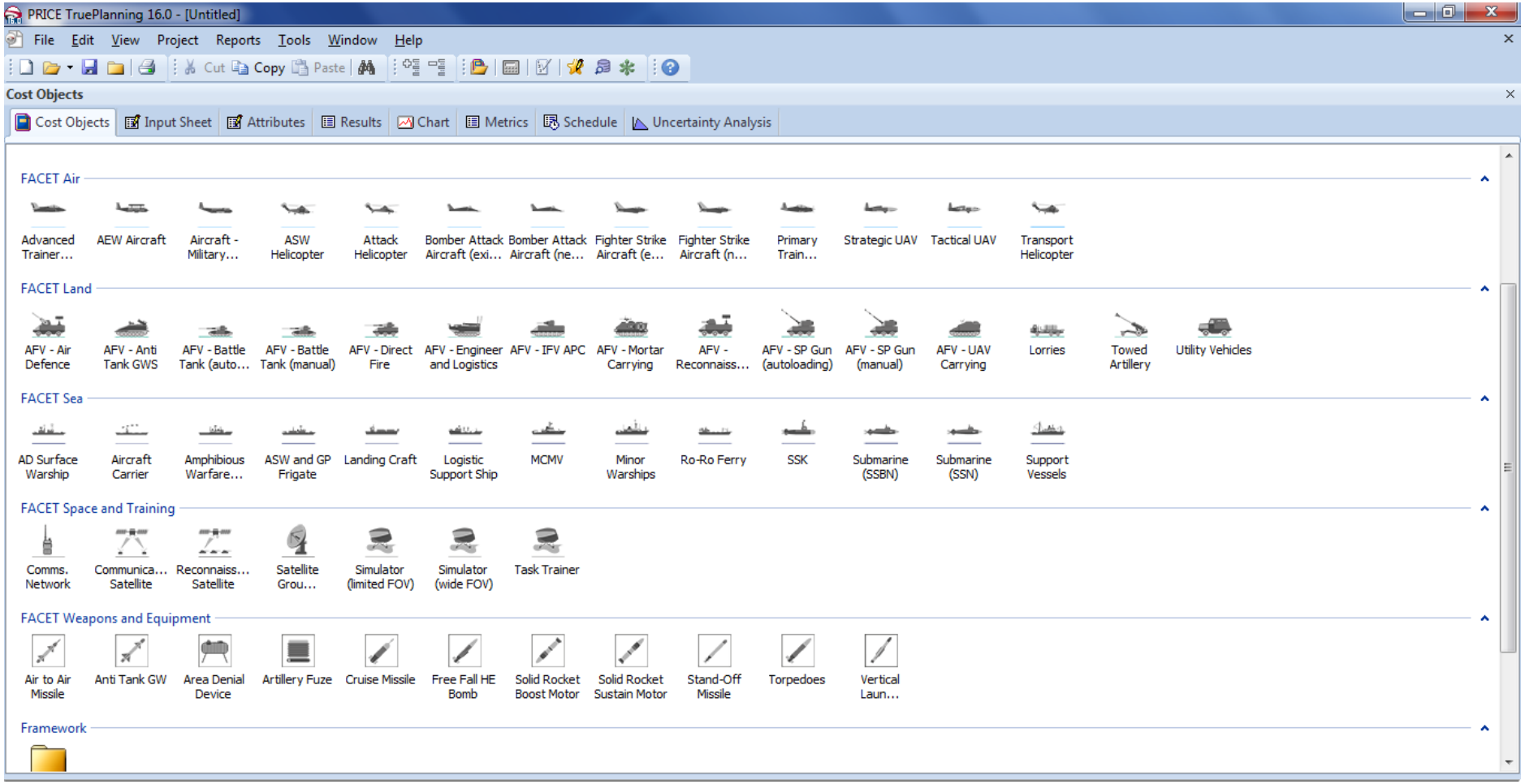
True FACET: Catalogues and Cost Objects



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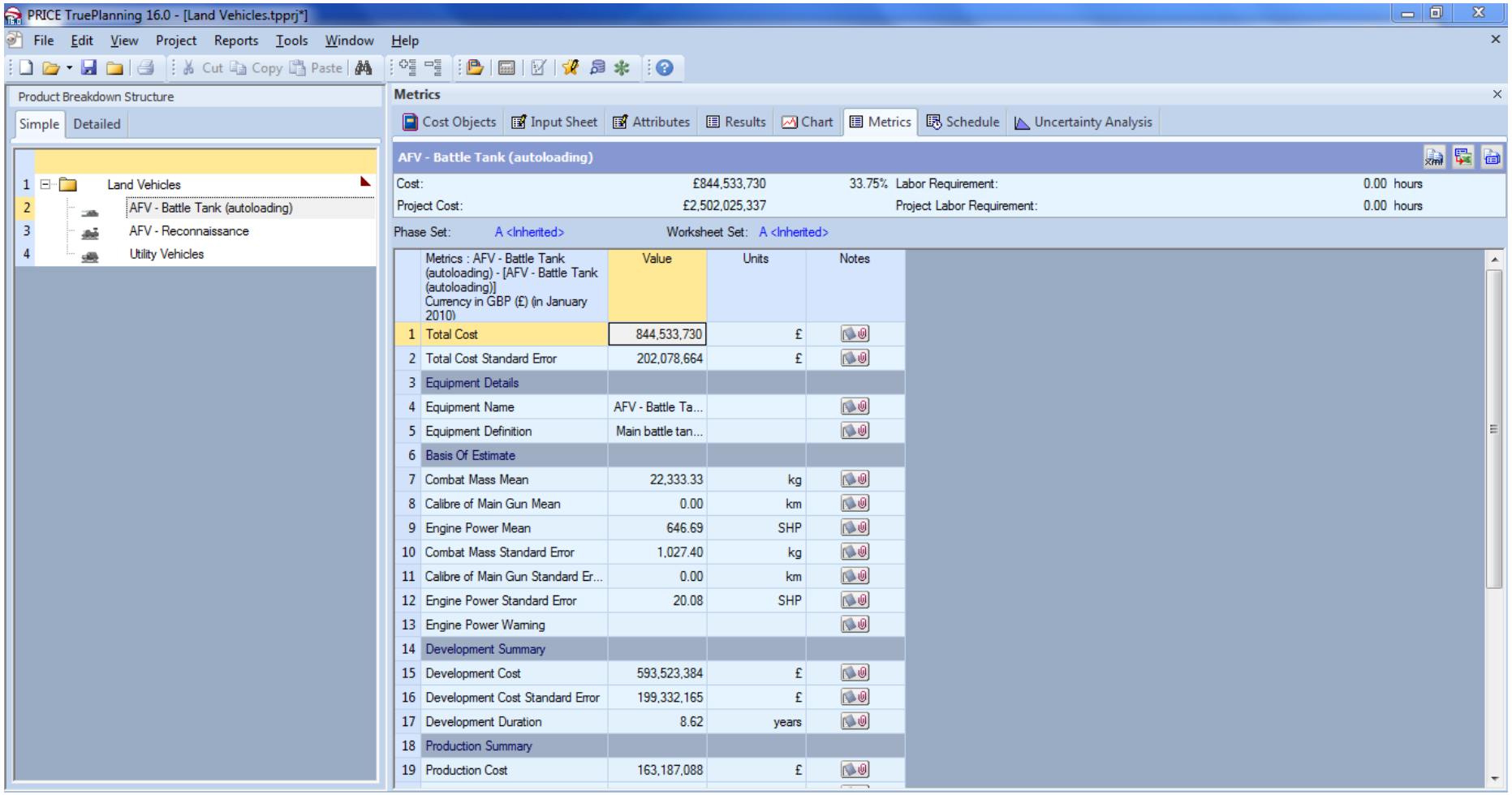
FACET WLC Models : Basis of Estimate in the metrics sheet



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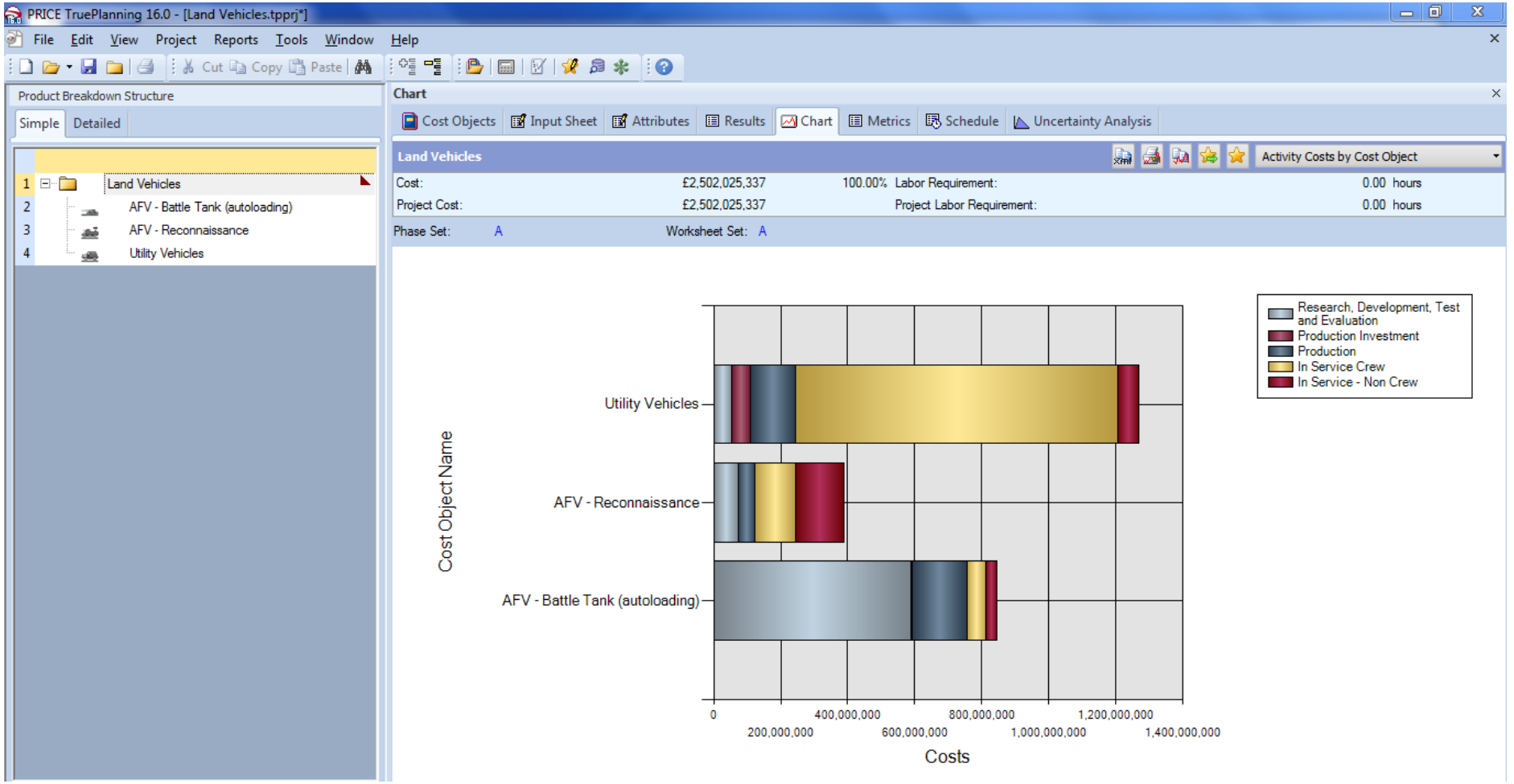
True FACET graphical output



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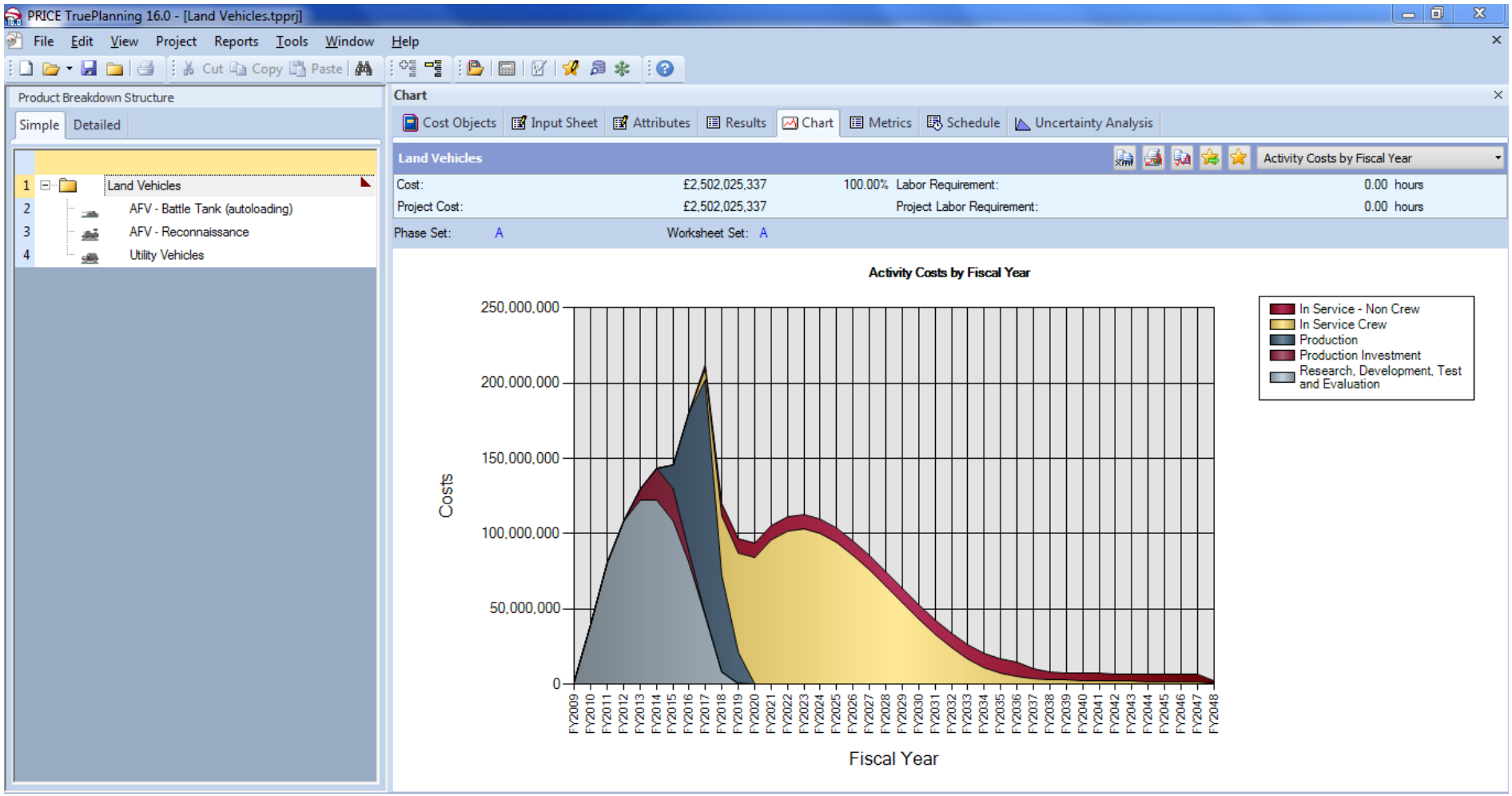
True FACET graphical output



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Applications of True FACET

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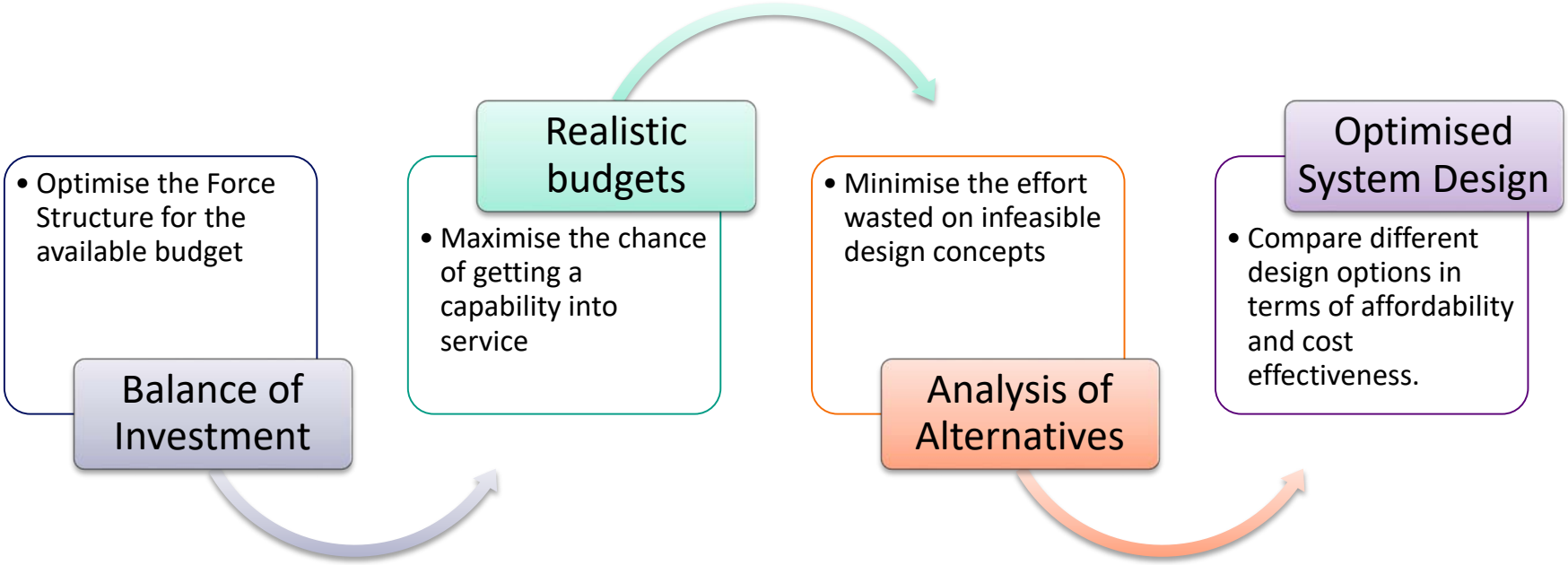
Applications: True FACET



Applications: Balance of Investment (BOI)

- **Consider high level policy and strategic questions to influence the shape and size of the current and future armed forces**

- **The ability to ask 'big picture' questions**
  - *"Is the army too big?"*
  - *"What is the spend profile if we delay the introduction of a new capability?*
- **Consideration of strategic policy changes**
  - *"Are there cost saving from merging elements of the services?"*
  - *"What would the services cost if all the rotary fleet were in a separate service?"*
- **Changes of acquisition strategy or political policy:**
  - *"How is the budget influenced by a pure sovereign manufacturing policy?"*
  - *"What is the impact of an Anglo-American procurement?"*

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Applications: Balance of Investment (BOI)

PRICE TruePlanning 16.0 - [Force Structure.tpprj*]

File Edit View Project Reports Tools Window Help

Cut Copy Paste

Product Breakdown Structure

Simple Detailed

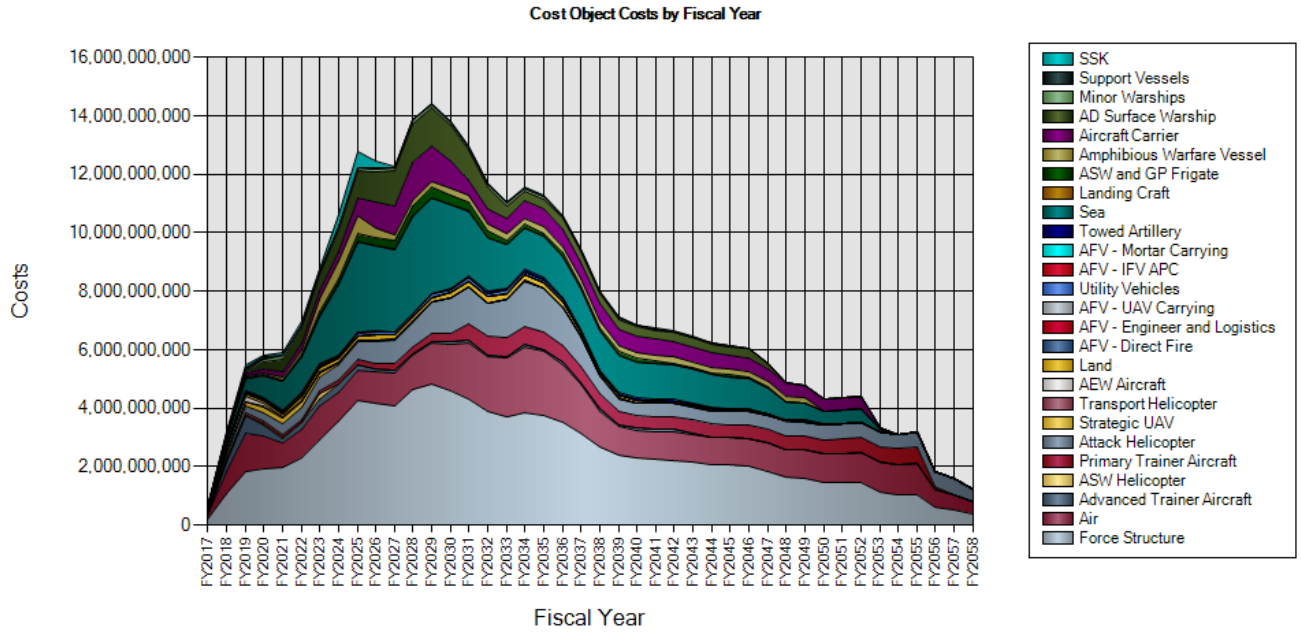
1	Force Structure
2	Air
3	Advanced Trainer Aircraft
4	ASW Helicopter
5	Primary Trainer Aircraft
6	Attack Helicopter
7	Strategic UAV
8	Transport Helicopter
9	AEW Aircraft
10	Land
11	AFV - Direct Fire
12	AFV - Engineer and Logistics
13	AFV - UAV Carrying
14	Utility Vehicles
15	AFV - IFV APC
16	AFV - Mortar Carrying
17	Towed Artillery
18	Sea
19	Landing Craft
20	ASW and GP Frigate
21	Amphibious Warfare Vessel
22	Aircraft Carrier
23	AD Surface Warship
24	Minor Warships
25	Support Vessels
26	SSK

Chart

Cost Objects | Input Sheet | Attributes | Results | Chart | Metrics | Schedule | Uncertainty Analysis

Force Structure — Cost Object Costs by Fiscal Year

Cost:	£102,715,658,438	100.00% Labor Requirement:	0.00 hours
Project Cost:	£102,715,658,438	Project Labor Requirement:	0.00 hours
Phase Set:	A	Worksheet Set:	A



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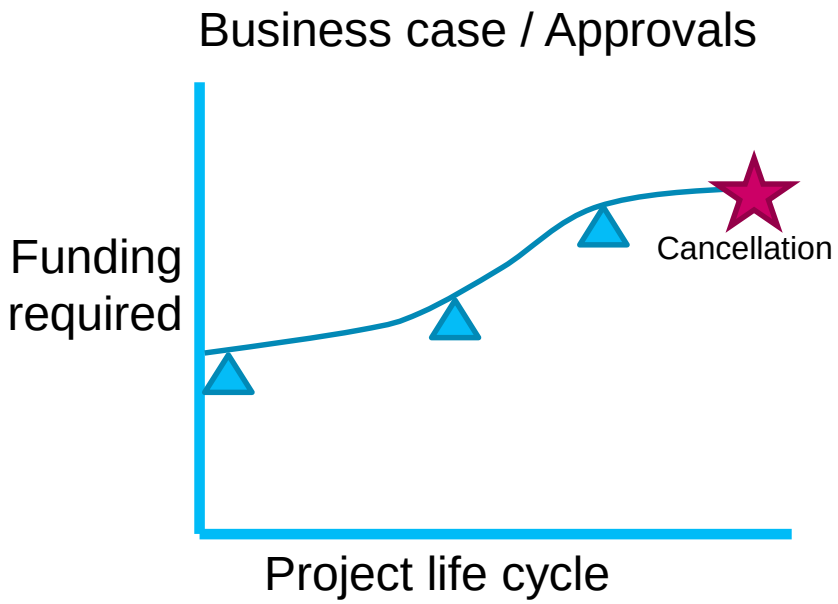
Applications: Early realistic budget setting

- **Set sufficient budget for the acquisition and support of a capability ensuring a legacy, exemplar project that avoids cancellation**
- **Avoid setting unrealistic budgets early at the genesis stage of a project**
  - *"I'm sure I read an article that these things cost X million"*
- **Which threaten the project at a later stage due to lack of realistic funding**
  - *"We need to discuss a fleet that is 70% of our need due to funding constraints or cancel the project"*
- **Based on limited information True FACET is able to provide realistic life cycle cost estimates early in the project life cycle to avoid unrealistic funding constraints and budget squeezes in later life.**



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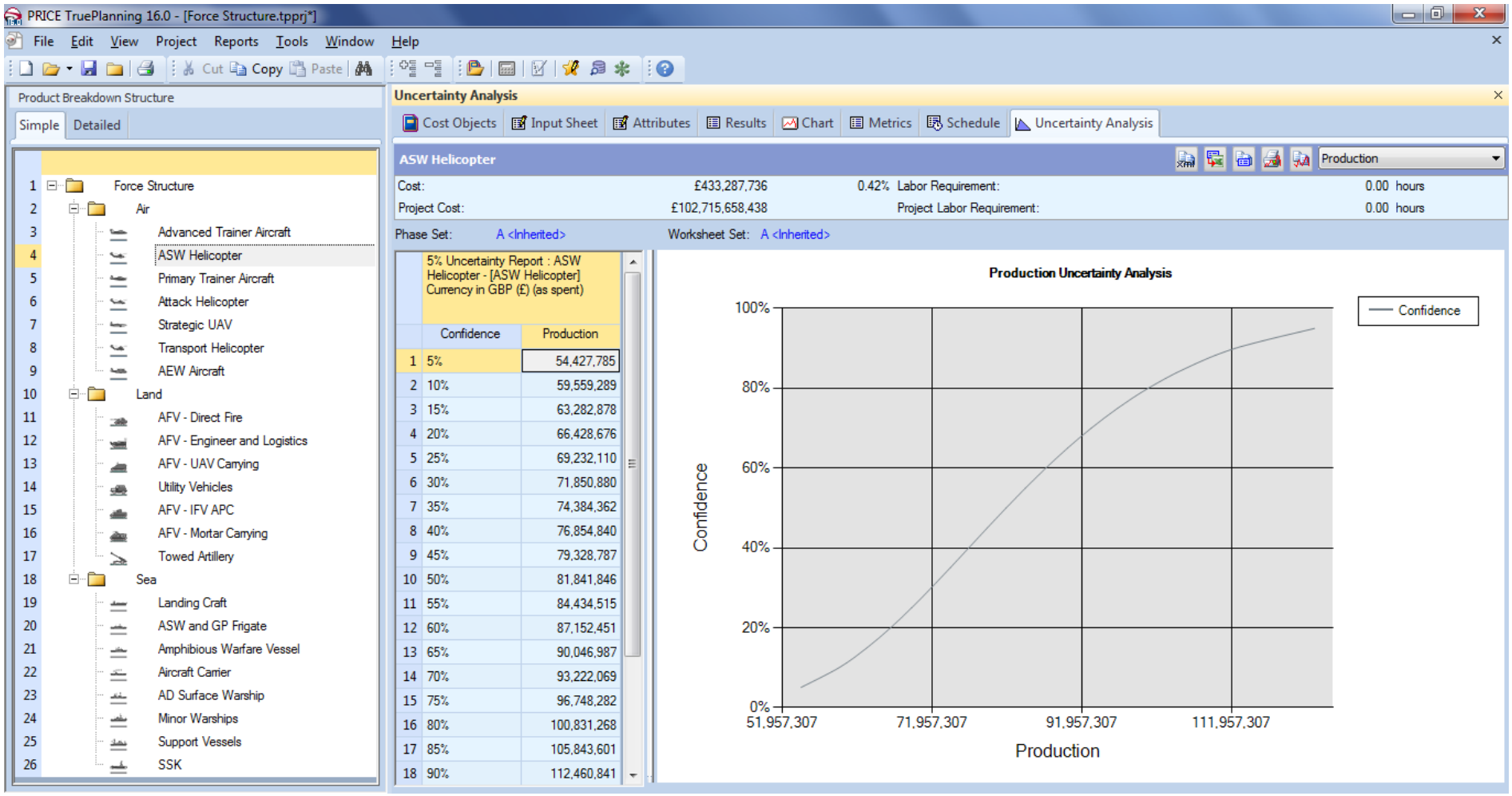
Applications: Early realistic budget setting



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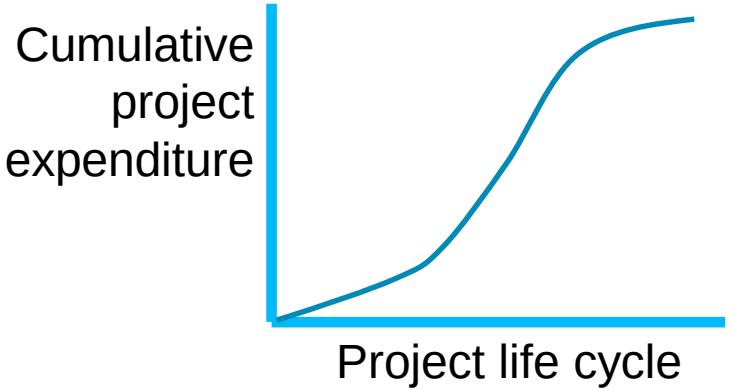
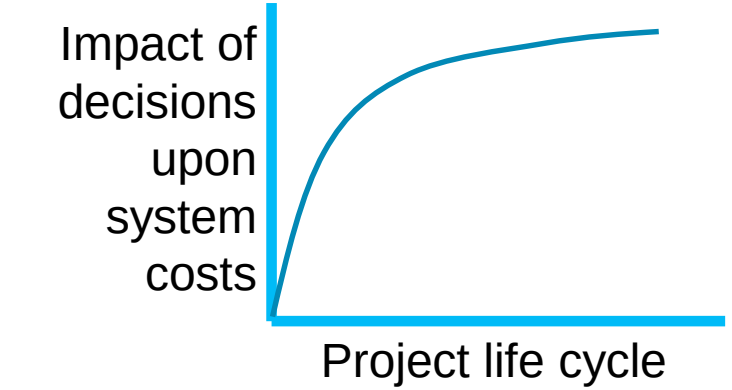
Applications: Analysis of Alternatives

- **Quickly explore the costs associated with viable systems that can satisfy the capability statement performance need with realistic designs**
- **During the initial period of the project life cycle there are the opportunities for project decisions to influence the Whole Life Cost at minimum expense to the overall project**
  - *"let's make it a wheeled vehicle"*
- **Once the project is approved and started any changes to the systems requirements or the systems design are huge**
  - *"it should have had tracks, can we discuss the options?"*
- **Based on limited information True FACET is able to provide realistic cost estimates early in the project life cycle to avoid unrealistic funding constraints in later life.**





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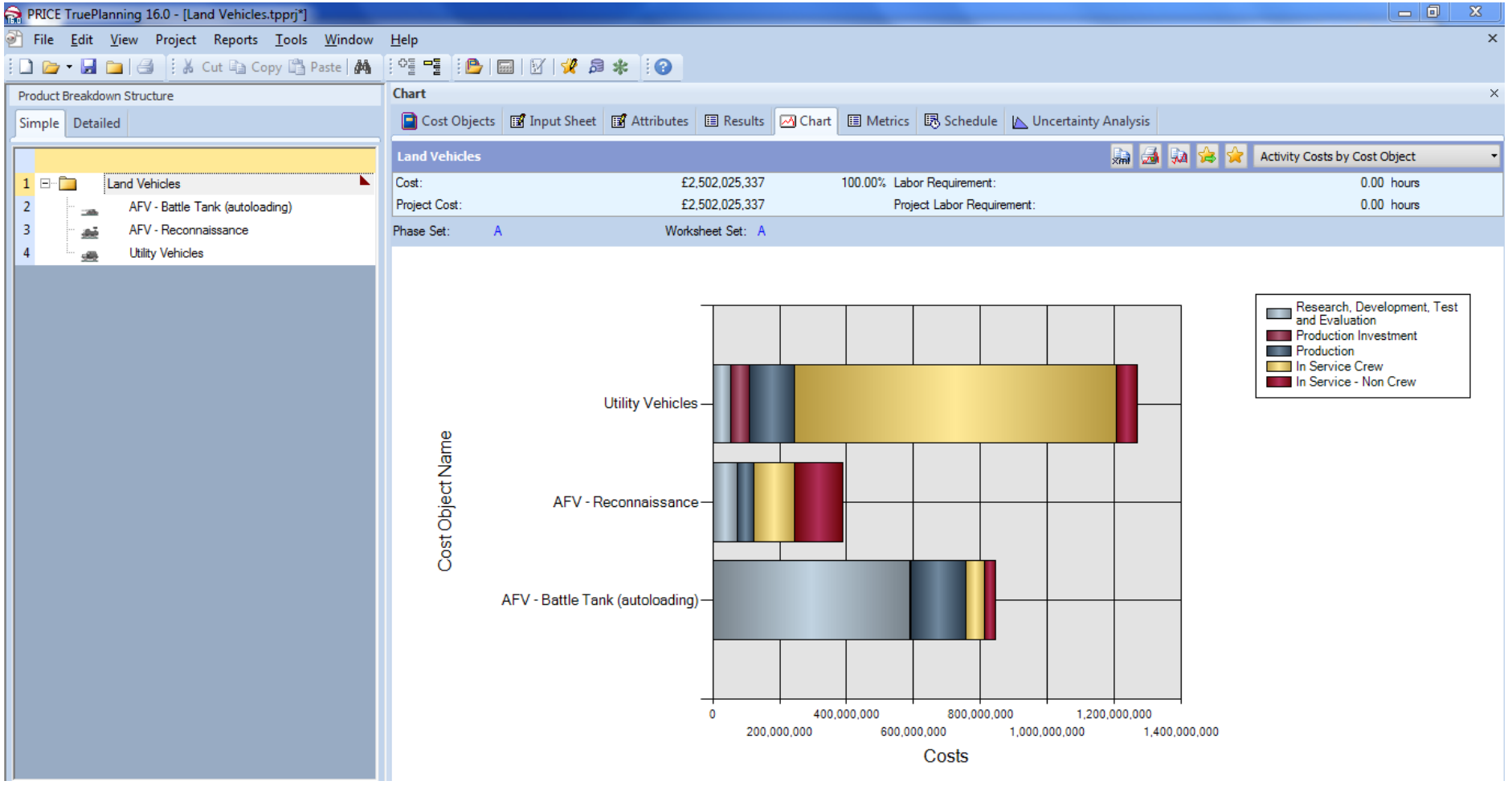
Applications: Analysis of Alternatives



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Application: Optimised system design

- **Compare different designs options in terms of affordability and cost effectiveness.**

- **True FACET has the ability to rapidly generate the whole life cost for multiple platform options including:**
  - Research, Develop Test and Evaluation (RDT&E)
  - Production Investment (PI)
  - Total Manufacture
  - Unit production cost (UPC)
  - Crew
  - Non-crew or maintenance

Option A


1 x Amphibious vessel


4 x Landing craft


2 x Helicopter

Option B


2 x Amphibious vessel


2 x Landing craft


1 x Helicopter

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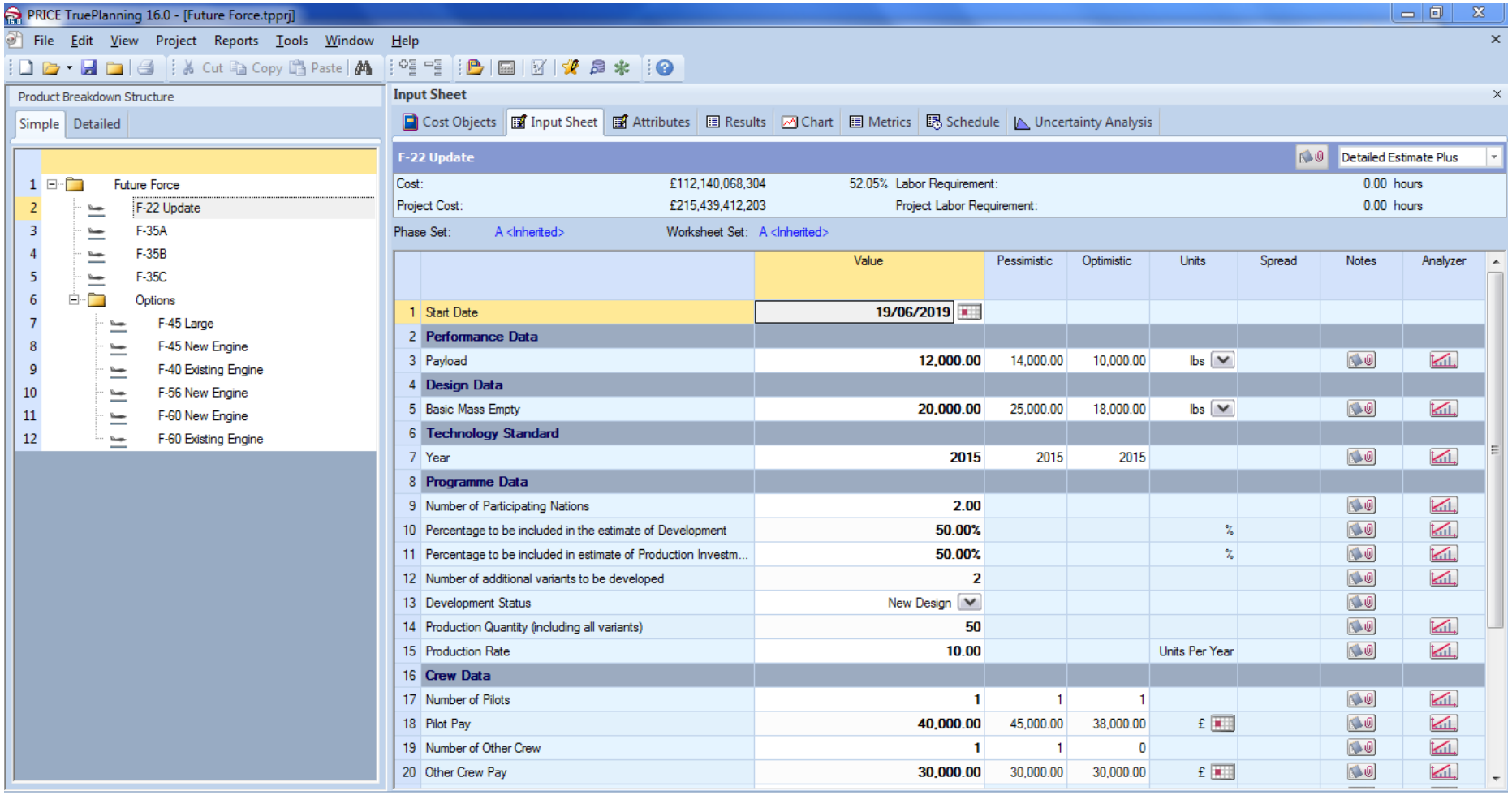
Application: Optimised system design



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Summary

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Conclusion

- **The combination of the FACET algorithms and the TruePlanning cost framework provides an excellent through life estimating capability**

- **Marco-parametric estimating is useful early in a project and has a number of applications, including, but not limited to:**
  - Balance of Investments
  - Realistic budget setting
  - Analysis of alternatives
  - Optimising the Systems design

- **With TruePlanning it is now possible to utilise FACET macro-parametric cost model and hardware, software and IT micro-parametric cost models seamlessly within a single framework saving time on training.**

Any Questions?

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QinetiQ Fellow / Head of
Profession Cost Engineering

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